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Citronella Incense Sticks as Mosquito Repellent and its Efficacy

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Abstract:- The study assessed the efficacy of mosquito repellent incense sticks formulated with citronella powder and citronella oil as F1 and F2 respectively. A total of 15 sample household were distributed both the samples for observation and recording about the efficacy of the incense sticks in repelling mosquito at Dopgre Village, Gambegre Block, West Garo Hills district, Meghalaya. The collected data were analysed using statistical tool and results revealed appreciable effectiveness of F2 than F1. The observation were based on the parameters of flammability, burning time, mosquito repellency, aesthetic appeal, odour, smoke creation and portability which are the common standards criteria for herbal based incense sticks for repelling mosquito or insects. The p-value (< .000) for the paired sample t-test is less than the standard significance level of 0.05 which confirmed that citronella oil extract can be effectively used to repel mosquito. Meghalaya being endemic to many mosquito associated diseases, The Dopgre villager of West Garo Hills district Meghalaya needed to be informed about the ease, convenient, accessibility and economics of using herbal based incense sticks for repelling mosquitoes.

Keywords*: Citronella leaves, Citronella oil, Incense sticks, Meghalaya and Mosquito repellent.*

1. Introduction

The importance of herbal based product is gaining momentum day by day. Among the consumer products incense stick or *agarbatti* is a common item used by many households especially in India. Herbal based incense stick is preferred because it doesn't contain lots of synthetic chemical. Chemical based substances are being discouraged especially those which is associated with human health hazard. We also see mosquito repellent incense sticks available commercially, but whether it is safe to use is a concern for many. Almost all synthetic mosquito repellents contain the active ingredient DEET (N, N-diethyl-3- methylbenzamide) which is a relatively dangerous synthetic chemical. Constant and indiscriminate use of these synthetic repellents causes adverse effects on the user [1], [2], [3]. To repel the mosquitoes many repellents in the form of liquid, coil, creme, lotion, patch etc. are being used. Mosquito repellents based on chemicals may be having a safety profile, but continuous uses leads to many health hazards. [4] also mentioned that mosquito repellents are toxic against the skin and nervous system.

Incense stick which is prepared out of herbal ingredients is eco-friendly, portable, cost effective and comparatively having nil untoward health effect as compared to other repellents available in the market [5]. Herbal or natural mosquito repellents were preferred than chemical based mosquito repellents [6]. The US Environmental Protection Agency (USEPA) has registered citronella, lemon, and eucalyptus oil as insect repellents due to their relatively low toxicity, high efficacy, and customer satisfaction [7].

Several studies in India and outside outlined about the presence of repellent properties in citronella. Citronella plant (*cympopogan n*) is a beautiful perennial clumping grass that emits a strong aroma [8]. The plant has strong aroma or fragrance which has lot of application. Moreover, many people prefer to use natural repellents extracted from plants, such as citronella oil, cedar, eucalyptus, geranium, lemon-grass, peppermint, neem, soybean, marigold. [2], [9]. Citronella is also found to be easily cultivated in northeastern states of India also.

The uses of citronella is not limited, the essential oil of the plant is also used in aromatherapy [10]. It has antiseptic, antifungal deodorant, insecticide and as well as stimulant medicinal properties [11]. Citronella obtained from lemongrass has a 100% repellency effect against Anopheles culicifacies for 11 h [12]. Formulations containing Cymbopogon Citrullus, Azadiracta indica and Eucalyptus globulus essential oils have the most promising activity exhibiting 80-95% repellency as compared to other repellant essential oils [6]. The essential oils commonly used as repellents are derived from Cymbopogon spp., Ocimum spp. and Eucalyptus spp. [13]. It is reported that mosquito coil containing leaves of citronella grass showed highest efficacy [4]. Citronella plants prevent the incidence of malaria among the residents housing [8].

North East India, having tropical climate is infested with several diseases such as malaria, dengue, etc. caused by mosquitoes [14]. Malaria is a principal cause of illness and death in countries where the disease is endemic. [15], [16] also mentioned that an estimated 96 million people with severe dengue require hospitalization each year, a large proportion of them are children. About 3.5% of the mortality rate was reported (WHO 2023). Dengue is very alarming and a fatal disease so minimizing the incidence is very important where the cases are found in large number.

West Garo Hills district in the state of Meghalaya in Northeast India lies between 25◦470 to 26◦100 N latitude and 89◦450 to 92◦470 E longitude (Kurien and et al., 2019). West Garo hill district is co-endemic for *Plasmodium falciparum* and *Plasmodium vivax*, but *P. falciparum* was the predominant infection (> 82%) [18]. In Meghalaya, 86% of the people belong to scheduled tribes and human settlement is mostly in the hilly terrain where mosquito may be swarming in large number.

It is crucial to formulate eco friendly, cost effective and portable mosquito repellent by using locally available resources to the maximum. It is imperative that the development of an active substance with good reluctance be developed in order to develop a new type of eco-friendly and safe mosquito repellent certification that can replace conventional mosquito insecticides, repellents and avoidance agents [19]. To add value, it (incense sticks) was later scented with essential oil like lemongrass oil and then dried [20]. The common parameters commonly used for analyzingherbal based mosquito repellent are based on flammability, burning time, repellency [14], [9].

2. Materials and Method

a. Study Area

The study was conducted at Dopgre Village, Gambegre Block, West Garo Hills District, Meghalaya in North Eastern Region of India. Garo tribe was randomly selected who are the resident of the village. The villager's main activity is agriculture and daily wages involed in cleaning, weeding of farms. The main agricultural crops grown are casewnut, rubber and arecanut. The study period was between May to August 2022 and the mosquitoes are also found to be swarming in large number because of monsoon. The study area is located at the latitude of 25.87 and longitude of 90.26.

b. Sample Collection and Preparation

For the study the researcher collected citronella leaves from Hajongpara village, Mellim, South West Garo Hills, Meghalaya where citronella cultivation was taking place. The leaves were dehydrated (5 days) in shade because sun drying was found to loss some fragrance from citronella leaves. After drying they were cut into small pieces with scissor and coarsely grinded in a grinder (simple household grinder) to a powder form, and kept in an air tight container to avoid any loss of fragrance.

The required materials for making the incense sticks namely carbon powder, jiggit/gum powder, dhoop powder and bamboo sticks were used for making the mosquito repellent incense sticks. These are collected from Larry Enterprise, Tura, Meghalaya.

c. Formulation of Incense Sticks

Composition for formulating the mosquito repellent incense sticks with citronella essential oil and with powdered citronella (Table 1). In a plastic bowl all the dry ingredients (powder) are mixed together and water is

added to form a paste. The paste is applied on the bamboo sticks and hand rolled over on some dhoop powder on the flat surface. After sun drying (2 days) citronella oil is applied with the help of paint brush on the dehydrated incense sticks (F2). In the (F1) no citronella essential oil was applied. The formulated incense sticks both with and without oil were distributed to the sample respondents in a separate packet.

Table 1. Composition for formulating the incense sticks

Sl. No.	Name of the Materials	Amount	
		With Citronella Powder (F 1)	With Citronella Oil (F 2)
1	Carbon powder	125 g	125 g
2	Gum powder	60 g	60 g
3	Dhoop powder	10 g	10 g
4	Water	100 ml	100 ml
5	Bamboo sticks	300 g	300 g
6	Citronella powder	30 g	-
7	Citronella oil	Nil	50 ml

The formulated incense stick is 19 cm long weighing about 2 gm has burning duration of one hour twenty minutes in a room. For comparing the two samples i.e. incense sticks with oil (F2) and with citronella powder (F1), the volunteer (public) observation were recorded. They reported that most of mosquitoes were repelled and gives a natural fragrance while burning the incense stick with oil (F2). The incense sticks with just citronella powder (F1) doesn't repel mosquito much as compared to (F2).

To collect the data a questionnaire schedule was used to collect the data for evaluation of mosquito repellent incense sticks and its efficacy. The mosquito repellent incense sticks were randomly distributed to fifteen household of the Dopgre Village. The sample respondents were asked to record the observation in a provided questionnaire schedule efor incense sticks (F1 and F2) each for five days. Proper oral instruction (in garo language) were also given to burn the mosquito repellent incense sticks. The samples respondents were asked to observe and rate the flammability, burning time, mosquito repellency, aesthetic appeal, odour, smoke creation, and portability of the formulated incense sticks.

3. Data Analysis

Statistical Package for the Social Sciences (SPSS) software version 29.0 was used to analyse the Paired t test. It is used to determine whether there is efficacy difference between F1 and F2 on the same respondents. It was also used because the sample respondent size (15) was less and village is not densely populated. The overall score from each items of observation namely flammability, burning time, mosquito repellency, aesthetic appeal, odour, smoke creation and portability are summated after analyzing their ratings.

4. Result

A paired samples t-test showed that the villager respondent's observation regarding the efficacy of incense sticks in repelling the mosquitoes in with citronella powder is ($M = 52.00$, $SD = 6.80$) and with citronella oil is ($M = 66.80$, $SD = 3.02$; $t = -8.488$, $p < .000$). This indicates that incense stick with the application of citronella essential oil is overall more effective in repelling the mosquitoes. Table 2 shows the frequency of items of observation by the sample respondents. The ratings are denoted by initial namely P –Poor, F- Fair, G-Good, VG –Very Good and E- Excellent.

Table 2. Distribution of ratings given by sample respondents

Sl. No.	Items of Observation	Distribution of respondents record and frequency n=15	
		With Citronella Powder (F 1)	With Citronella Oil (F 2)
1	Flammability	F 2(13), G 11(74), VG 2(13)	G 2(13), VG 9(60), E 4(27)
2	Burning Time	G 15(100)	F 3(20), G 12(80)
3	Mosquito Repellency	G 3(20), VG 12(80),	VG 2(13), E 13(87)
4	Aesthetic Appeal	P 11(74), F 4(26)	F 14(93), G 1(7)
5	Odour	G 11(73), VG 3(20), E 1(7)	VG 10(67), E 5(33)
6	Smoke Creation	G 12(80), VG 3(20)	G 10(67), VG 3(20), E 2(13)
7	Portability	G 1(7), VG 11(73), 3(20)	G 1(7), VG 11(73), E 3(20)

5. Discussion

This study found that citronella plant extract are effective in repelling the mosquitoes. Both the formulated samples F1 and F2 can repel mosquito but F2, i.e. with citronella oil is having more efficacy. The study also correlates with [4] that mosquito coil containing leaves of citronella grass showed highest efficacy. The formulated hand rolled incense sticks/agarbatti is very much applicable in hilly region especially because of its portability. A study by [5] also mentioned that incense sticks prepared is cost effective, easily portable. The agrarian lifestyle of garo hills people where accessibility to regular electric supply and buying commercially available mosquito repellent is a cost matter. The easily and locally available resources namely citronella plant can be effectively used to repel mosquito in the region. The raw materials required for making the herbal based mosquito repellent is economical as compared to commercially available repellents. [21] in their study also mentioned that mosquito control activities not to cause harm to humans and the environment. Citronella species is commonly accepted as a mosquito repellent plant which is safe to use and is registered by US Environmental Protection Agency (USEPA).

6. Conclusion

This study assessed the efficacy of mosquito repellents formulated from citronella (*cymbopogan nardus*) extract in West Garo Hills of Meghalaya. Results showed appreciable efficacy in repelling mosquito from formulated sample F1 and F2. Most of the observation reveals that the F2 sample i.e. formulated with essential citronella oil is more effective as compared to F1, where citronella leaves powder was usedin the formulation. The study showed that citronella powder based incense sticks is also effective in repelling the mosquito and economical. The villagers can easily access this citronella plants and can make their own incense stick for repelling mosquito. The health risk associated with the using of commercially available synthetic mosquito repellent is a matter of concern as well as costly. Villagers require awareness and education to safeguard health and encourage the use of low cost effective mosquito repellent based on citronella, which is commonly available and cultivated in the region.

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Conflict of Interests

The authors declare that there is no competing interest.

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